



# The repeatability and characteristics of right ventricular longitudinal strain imaging by speckle-tracking echocardiography in healthy dogs

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Received 14 December 2016; received in revised form 9 March 2017; accepted 15 May 2017

## KEYWORDS

Canine;  
Cardiac;  
Right ventricular  
function;  
Dyssynchrony;  
Tei index

**Abstract** *Introduction:* To assess the repeatability and characteristics of echocardiographic indices of the right ventricular (RV) function derived from speckle-tracking echocardiography.

*Animals:* Fourteen laboratory Beagles and 103 privately owned dogs without cardiac disease were involved in this study.

*Materials and methods:* Right ventricular longitudinal strain, strain rate, and a strain-related index for assessing RV dyssynchrony derived from speckle-tracking echocardiography were obtained by two different observers using five Beagles. Within-day, between-day, and interobserver coefficients of variation and the intra-class correlation coefficient of speckle-tracking echocardiography indices were determined. Both speckle-tracking echocardiography and conventional indices of RV function, including the peak velocity of systolic tricuspid annular motion, tricuspid annulus plane systolic excursion, fractional area change, and the Tei index, were

This study was partially supported by a Grant-in-Aid for Scientific Research from the Japanese Society for the Promotion of Science (No. 16K18800).

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<http://dx.doi.org/10.1016/j.jvc.2017.05.001>

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Please cite this article in press as: Morita T, et al., The repeatability and characteristics of right ventricular longitudinal strain imaging by speckle-tracking echocardiography in healthy dogs, Journal of Veterinary Cardiology (2017), <http://dx.doi.org/10.1016/j.jvc.2017.05.001>

obtained from 14 Beagles and 103 privately owned dogs. Relationships between echocardiographic indices and the body weight, heart rate, age, and sex were estimated by regression analysis.

**Results:** Speckle-tracking echocardiographic indices showed good within-day repeatability, between-day and interobserver repeatability were moderate to good. In large dogs, RV longitudinal strain, strain rate, and fractional area change were significantly decreased, while the index of RV dyssynchrony, systolic tricuspid annular motion, tricuspid annulus plane systolic excursion, and the Tei index were increased. All speckle-tracking and conventional echocardiographic indices were correlated with the body weight.

**Discussion and conclusions:** The speckle-tracking echocardiography indices were highly repeatable and body weight affected speckle-tracking echocardiography indices in dogs. Further studies are needed to apply speckle-tracking echocardiography indices in dogs with cardiac disease.

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### Abbreviations

BW	body weight
FAC	fractional area change
ICC	intraclass correlation coefficient
PAH	pulmonary arterial hypertension
RV	right ventricle
RVEDA	RV end-diastolic area
RVESA	right ventricular end-systolic area
RVLS	right ventricular longitudinal strain
RVLSRs	right ventricular longitudinal strain rate
RV-SD6	standard deviation of the time to peak longitudinal strain of the 6 segments of right ventricle
$S'_{TV}$	peak velocity of systolic tricuspid annular motion as determined by tissue Doppler imaging
SD	standard deviation
STE	speckle-tracking echocardiography
TAPSE	tricuspid annulus plane systolic excursion

The physiological importance of the right ventricle (RV) has long been underestimated. However, RV function assessed by magnetic resonance imaging, cardiac catheterization, and echocardiography is closely associated with clinical outcome in human patients with not only right heart disease, such as pulmonary arterial hypertension (PAH) [1,2] and arrhythmogenic right ventricular cardiomyopathy [3], but also with left heart diseases, such as mitral valvular disease [4],

and dilated cardiomyopathy [5]. Additionally, RV intraventricular mechanical dyssynchrony, which is caused by RV pressure overload, dilation, hypertrophy, electrical activation delay, and non-uniform distribution of myocardium wall stress, has recently been described in PAH patients, and is associated with more pronounced RV dysfunction [6,7]. Therefore, assessment of the RV function has garnered increasing interest in human medicine.

However, accurate assessment of the RV function by echocardiography is challenging because of its complex geometry and contractile properties. To date, echocardiographic indices of RV function assessment such as the peak velocity of systolic tricuspid annular motion determined from tissue Doppler ( $S'_{TV}$ ) and the tricuspid annulus plane systolic excursion (TAPSE) by M-mode have been used clinically in humans and dogs [8–10]. These parameters, however, have some limitations: angle dependence and only regional assessment of the tricuspid annulus. In addition, fractional area change and the Tei index have been applied for the assessment of RV function in humans and dogs [11–14].

Speckle-tracking echocardiography (STE) is a novel quantitative method for assessment of both regional and global myocardial deformation from grayscale B-mode images. This method can be used to evaluate ventricular performance, such as the strain, strain rate, and dyssynchrony index, without the problems of angle dependence and geometric assumptions [15]. In humans, STE has been applied for the analysis of the left ventricular, left atrial, and RV function, and demonstrated to be a feasible and sensitive quantitative technique [16]. Right ventricular longitudinal strain (RVLS) and the

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